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Bridge Monitoring and Alert Generation System Using IoT

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Abstract

An IoT based Bridge Safety Monitoring System is developed using the wireless technology. This system is composed of monitoring devices installed in the bridge environment including the communication devices connecting the bridge monitoring devices and the cloud-based server, and a cloud-based server that calculates and analyzes data transmitted from the monitoring devices. This system can monitor and analyze the conditions of a bridge and its environment, including the water level force levels nearby, vibration and other safety conditions. The detected data are transmitted to the server and database for users to have real-time monitoring of the bridge conditions with the help of mobile telecommunication devices. Many bridges in cites are at theriver bank which are mostly not in good conditions as they had been constructed long years ago which need to maintained on regular basis. Due to heavy load of vehicles, high water flow, heavy rains these bridges may get collapse which in turn leads to disaster. So, these bridges require continuous monitoring. So, this paper proposes a system which consists of a weight sensor, vibration sensor, water force sensor, Wi-Fi module, and ARM microcontroller. This system detects the load of vehicles and if the value rises above threshold, it generates an alarm, then the concerned authority can assign the task to the employees for maintenance.

Keyword: IoT, ARM Microcontroller, WSN, Load, Force, Vibration.

1. INTRODUCTION

This system is composed of monitoring devices installed in the bridge environment, communication devices connecting the bridge monitoring devices and the cloud-based server, a dynamic database that stores bridge condition data and a cloud based server that calculates and analyses data transmitted from the monitoring devices. This system can monitor and analyses in real time the conditions of a bridge and its environment, including the waters levels nearby, pipelines, air and other safety conditions. The detected data and images are transmitted to the server and database for users to have real time monitoring of the bridge conditions via mobile telecommunication devices. The data can be usedfor bridge safety management and, in the occurrence of a disaster, for disaster rescue. For its monitoring and information communication, this system uses the Wi Fi technology, a technology characterized by low power consumption, high safety and support of a large number of network works. In addition, solar energy is used as a supplementary power source for the system to reduce its costs. The system developed in this study can help promote the advancement of bridge safety management and control by providing breakthroughs to the above-mentioned problems of conventional systems.

2. LITERATURE SURVEY

Jin-Lian Lee et al (2017) explained about that an IoT-based bridge safety monitoring system is developed using the ZigBee technology. This system is composed of monitoring devices installed in the bridge environment, communication devices connecting the bridge monitoring devices and the cloud-based server, a dynamic database thatstores bridge condition data, and a cloud-based server that calculates and analyses data transmitted from the monitoring devices. This system can monitor and analyse in real time the conditions of a bridge and its environment, including the waters levels nearby, pipelines, air and other safety conditions. The detected data and images are transmitted to the server and database for users to have real time monitoring of the bridge conditions via mobile telecommunication devices.

Pradeep Kumara V. H. D. C. Shubhangi (2020) discussed the impact of the bridges get damaged due to aging or damage due to natural calamities, the people will remain unnoticed of it. Then the bridges will bea danger to travel as it can collapse anytime and leads to disaster. So, continuous bridge checking must be done for better bridge health. For solving this problem, a design for continuous bridge monitoring has been proposed using wireless IoT technology. This proposed design helps in monitoring bridges and can also be applied for flyovers. The design consists of monitoring devices as sensors like load sensor, water level sensor, vibration sensor and tilt sensor which are interfaced with communication devices. For storing the status of a bridge, a database is used. The processor is being used for calculation and analysing the data which is received by the monitoring devices. The design monitors the real-time condition of bridges and flyovers. The proposed is implemented at a low cost.

Lingzhi Yi et al (2020) suggested that the Internet of Things (IoT) based Bridge Structural Health Monitoring (BSHM) has recently attracted considerable attention from both academic and industrial communities of civil engineering and computer science. In conjunction with researchers from civil engineering and computer science, this paper studied a fundamental problem motivated from practical IoT-based BSHM: how to effectively prolong network lifetime while guaranteeing desired coverage. Integrating a promising reinforcement learning model named Learning Automata with Confident Information Coverage (CIC) model, this paper presented an energy-efficient sensor scheduling strategy for partial CIC coverage in IoT-based BSHM system to guarantee network coverage and prolong network lifetime. The proposed scheme fully exploits cooperation among deployed nodes and alternatively schedules the wake/sleep status of nodes while satisfying network connectivity and partial coverage ratio. Specially, the proposed scheme takes full advantage of the learning automata model to adaptively learn the optimal sensor scheduling strategy and significantly extend network lifetime. A series of comparison simulations using real data sets collected by a practical BSHM system strongly verify the effectiveness and energy efficiency of the proposed algorithm. To the best of our knowledge, this is the first study on how to combine the reinforcement learning mechanism with partial coverage for maximizing the network lifetime of the IoT-based BSHM.

3. METHODOLOGY

In this paper, the circuit is designed to monitor the bridge and generate an alert using IoT and WSN technologies.

3.1 Arduino Uno

An Arduino is actually a microcontroller, based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open source hardware feature. It is basically used in communications and in controlling or operating many devices. It was founded by Massimo Banzi and David Cuartielles in 2005. The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USBto-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward.

3.2 Vibration Sensor

Vibration sensors are used in a number of different projects, machines and applications. Whether you're attempting to gauge the speed of a vehicle, or to gauge the power of an impending earthquake, the device you're likely using is considered to be a vibration sensor. Some of them operate on their own, and others require their own power source. Various machine operating conditions concerning temperature extremes, magnetic fields, vibration range, frequency range, electromagnetic compatibility (EMC) and electrostatic discharge (ESD) conditions and the required signal quality necessitate the need for a variety of sensors.

3.3 Load Cell

Resistive load cells work on the principle of Piezo-resistivity. When a load/force/stress is applied to the sensor, it changes its resistance. This change in resistance leads to a change in output voltage when a input voltage is applied. The load or force cell takes many forms to accommodate the variety of uses throughout research and industrial applications. The majority of today’s designs use strain gauges as the sensing element, whether foil or semiconductor.

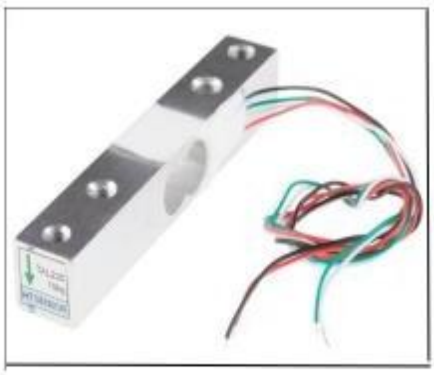

Fig 3.1 Load Cell

3.4 Force Sensor

A force-sensing resistor is a material whose resistance changes when a force or pressure is applied. They are also known as force-sensitive resistor and are sometimes referred to by the initialize FSR. Force-sensing resistors consist of a conductive polymer, which changes resistance in a predictable manner following application of force to its surface. They are 31 normally supplied as a polymer sheet or ink that can be applied by screen printing. The sensing film consists of both electrically conducting and non-conducting particles suspended in matrix. The particles are sub-micrometer sizes, and are formulated to reduce the temperature dependence, improve mechanical properties and increase surface durability. Applying a force to the surface of the sensing film causes particles to touch the conducting electrodes, changing the resistance of the film. As with all resistive based sensors, force-sensing resistors require a relatively simple interface and can operate satisfactorily in moderately hostile environments. Compared to other force sensors, the advantages of FSRs are their size, low cost and good shock resistance.

Fig 3.2 Force Sensor

4. BLOCK DIAGRAM

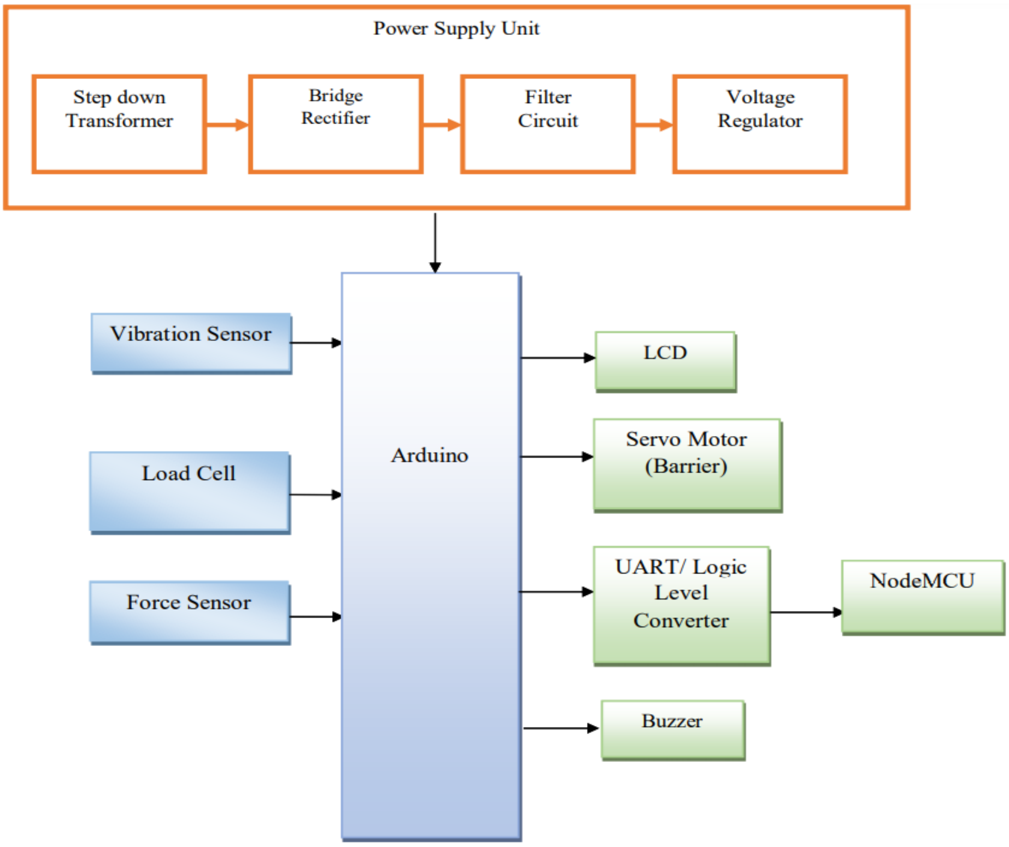

Fig 4.1 Block Diagram

5. WORKING AND RESULTS

5.1 Working

Arduino Uno consists of 14 digital inputs/output pins, each of which provide or take up 40mA current. Some of them have special functions like pins 0 and 1, which act as Rx and Tx respectively, for serial communication, pins 2 and 3- which are external interrupts, pins 3,5,6,9,11 which provides PWM output and pin 13 where LED is connected. The light rays passing through the LCD would be rotated by the polarizer, which would result in activating/highlighting thedesired characters. The power supply should be of +5v, with maximum allowable transients of 10mv. To achieve a better/suitable contrast for the display the voltage at pin 3 should be adjusted properly. The ground terminal of the power supply must be isolated properly so that voltage is induced in it. The module should be isolated properly so that stray voltages are not induced, which could cause a flicking display. A servo consists of a Motor (DC or AC), a potentiometer, gear assembly and a controlling circuit. First, we use gear assembly to reduce RPM and to increasetorque of motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is noelectrical signal generated at the output.

Now an electrical signal is given to another input terminal of the error detector amplifier. Now difference between these two signals, one comes from potentiometer and another comes from other source, will be processed in feedback mechanism and output will be provided in term of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with potentiometer and as motor rotates so the potentiometer and it will generate a signal.

After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

5.2 Results

Here we have discussed the different methods used by the researcher to monitor the bridge condition. Such a system will help to control the dynamic parameters of the bridge for preventing it from the disaster which can save the many lives and also wealth. This system is unique in its ability to monitor the bridge environment, transmit the environmental data through wireless communication and send alerts to the bridge management staff in real time for prompt reactions. This system can enable 24x7 bridge safety management as well as prompt and appropriate. Responses to emergency incidents. The system continuously monitors the bridge parameter value and judges whether the bridge is safe or not for traveling. In case the parameter values are beyond the threshold values then an alert sound is given to the people. The implementation is greatly useful.

The proposed system is developed by IoT and WSN technologies. In the proposed system, the hardware module consists of a weight sensor, vibration sensor, water force sensor, Wi-Fi module, and ARM microcontroller. This system detects the load of vehicles and if the value rises above threshold, it generates an alarm. If the value rises above the particular value, it sends the notification message and the values are displayed in the LCD display. Then the barrier gate is used to close the entry way if anything happens in the bridge for that we used the DC Motor to close the gate.

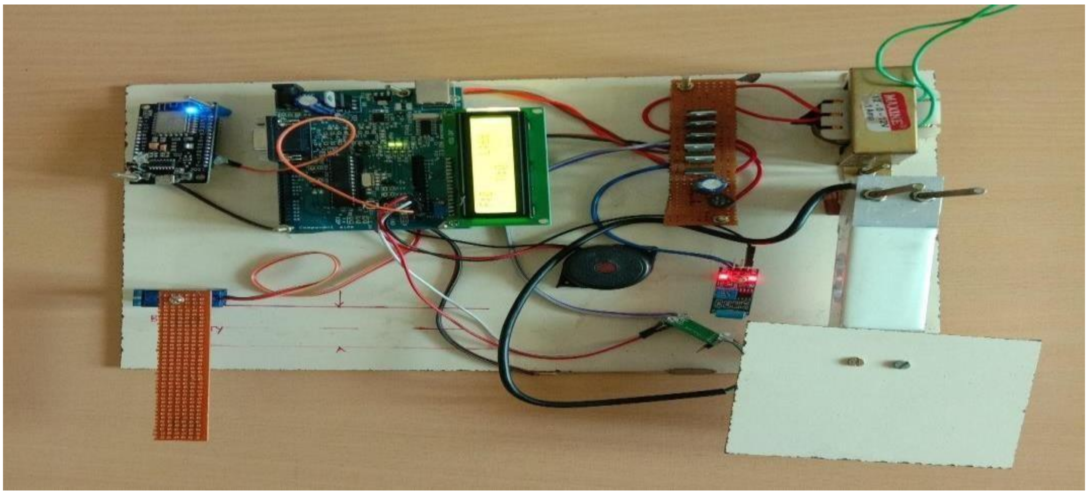

Fig 5.1 Prototype Model

6. CONCLUSION AND FUTURE SCOPE

In this paper, the working of Bridge Monitoring and alert generation system using IoT, we can display data using LCD display and IOT when there are signs of collapsing the bridge. This system will help to reduce major disasters in future. This system can save the lives of many people. The IoT integrated with the sensors presents the solution for the damage detection in bridges. The proposed system can give information about the change in angle of the bridge. A bridge monitoring system is needed for public safety. Such system can be designed using TCP/IP protocol for connection between sensor and Arduino, Wi-Fi module. The principal objective is to detect the damages in bridges by the use of sensor network. The Internet of things integrated with the sensors presents a solution for damage in bridge health monitoring.

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